2003

G03-1528 Recommended Seeding Rates and Hybrid Selection for Rainfed (Dryland) Corn in Nebraska

Robert N. Klein
University of Nebraska - Lincoln, robert.klein@unl.edu

Drew J. Lyon
University of Nebraska-Lincoln, drew.lyon@wsu.edu

NebGuide
University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources
Know how. Know now.

G1528

Recommended Seeding Rates and Hybrid Selection for Rainfed (Dryland) Corn in Nebraska

Robert N. Klein, Extension Cropping Systems Specialist, and
Drew J. Lyon, Extension Dryland Crops Specialist

This NebGuide provides information useful in assessing accumulated growing degree days, soil type and field conditions, average precipitation, and the field's microclimate when determining seeding rate for dryland corn.

Differences in climate between Lincoln and Scottsbluff are as great as from Lincoln to the east coast of the United States. These climatic differences across the state greatly affect recommended seeding rates for rainfed corn in Nebraska. The mean summer water balances (the cumulative differences between monthly precipitation and potential evapotranspiration for June, July, and August) across Nebraska are illustrated in *Figure 1*. These values range from a deficit of 4 inches in areas of southeast Nebraska to a deficit of as much as 10 inches in portions of northwest Nebraska. The water balance for June, July and August assumes 100 percent effective rainfall; however, warm season rainfall on bare soil can be as low as 20 percent efficient due to evaporation, runoff, and weed use. Total crop water use for a crop also must include the time from plant establishment to maturity. When you also consider differences in soil types, depth of soil, growing degree days *(Figure 2)*, plus the many other variables that affect crop production, you begin to understand the need for a wide range of seeding rates for rainfed corn in Nebraska.

Optimum seeding rates also are affected by the hybrid selected. This includes the relative maturity, stress tolerance, prolificacy, and stalk lodging resistance. Full-season hybrids have the greatest yield potential. A mid-season hybrid at one location may be a full-season hybrid at another location since season length varies greatly across the state. Length of growing season is affected not only by the number of days from the last frost in the spring until the first frost in the fall, but also by latitude and altitude. The field microclimate associated with residue cover greatly influences plant response to climatic conditions.

The biggest risk is selecting hybrids that are too extreme in maturity. A short-season hybrid has a lower yield potential than a long-season hybrid; however, moisture limitations, frost, or both may limit performance of the long-season hybrid in some years. The most frequent problem is with corn hybrids that mature too late. If a full-season hybrid has been used under conventional farming methods, it may be late if no-till methods are used. A mid-season hybrid for the area probably would be preferred in a no-till system.

At planting, the only real guides to the crop year are the amount of stored water in the soil profile, the amount of crop residue, and planned tillage and cultivation. Within limits, these can be used to help decide how late the hybrid maturity should be. The more stored soil water available, the later you can stretch the maturity range in hybrid selection, but use this recommendation cautiously and avoid going to the extreme unless you are ready to assume the risk of a crop badly damaged by early frost or drought.

The amount of crop residue present at planting and maintained during the growing season affects soil moisture. In general, increasing quantities of crop residue will reduce soil evaporation and wind speed, increase water infiltration, and decrease water use by weeds by suppressing weed growth. Four to six thousand pounds of crop residue per acre usually are required to maximize rainfed corn yields in Nebraska.

Full-season hybrids are also more risky when high plant populations are used. With a greater amount of soil water at planting, it is usually preferable to increase the planting rate rather than switch from a mid-season to a full-season hybrid. If full-season hybrids are used, reduce the plant population. Generally, for every four-day reduction in hybrid maturity, one less inch water is required. This large amount may only be true in well watered conditions. For example, studies conducted with adequate soil moisture have shown that with a 2400 or

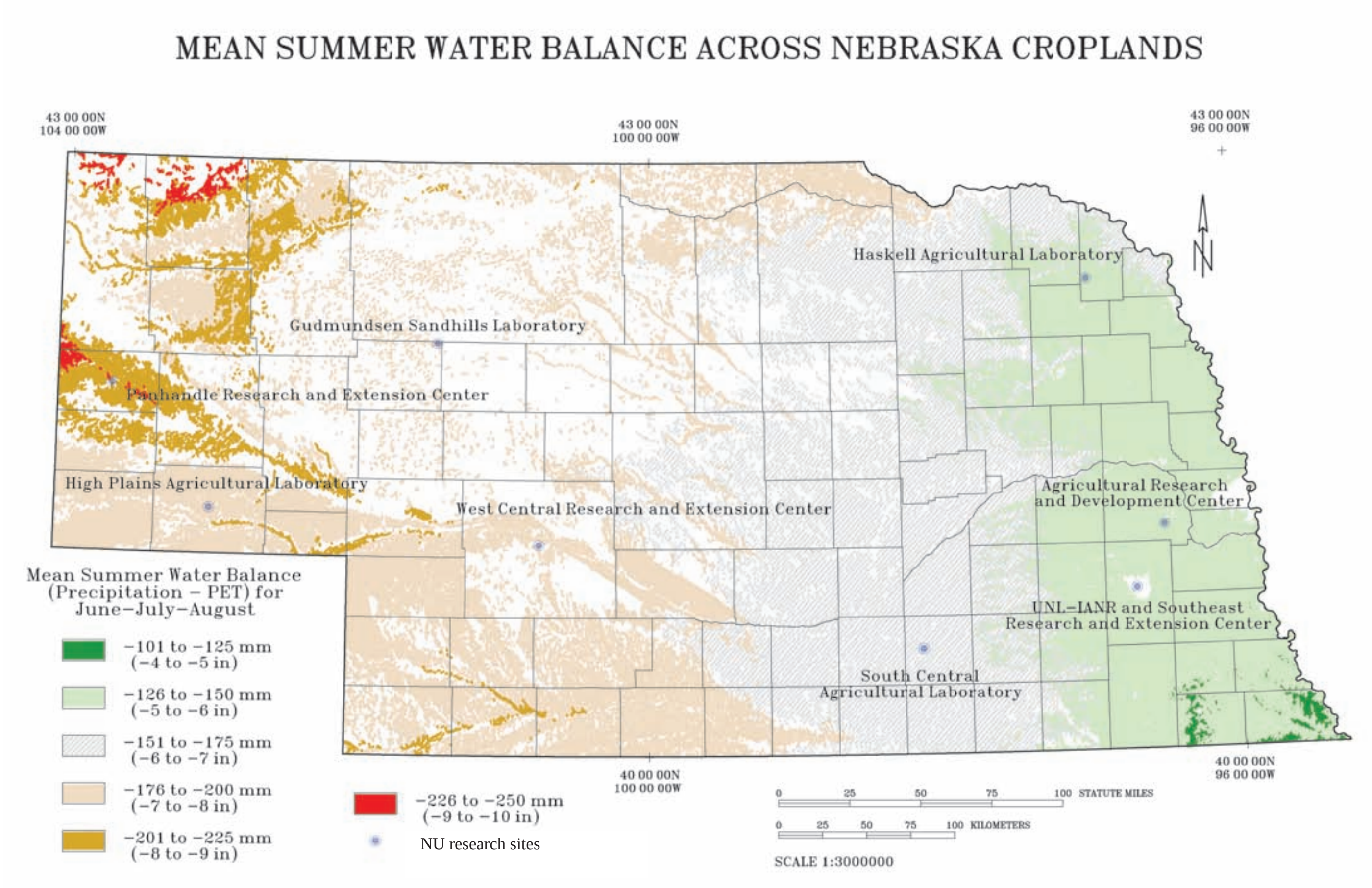

Figure 1. Mean summer water balances for Nebraska cropland for June-August, representative of the cumulative differences between precipitation and evapotranspiration. Mean summer water balances were derived from the Newhall Simulation Model (Van Wambeke et al., 1992) using 1961 to 1990 normals for precipitation and temperature from a population of 125 weather stations (Owenby and Ezell, 1992). Croplands were derived from the 1:250,000 Land Use and Land Cover Digital Data (USGS, 1986). (From Geospatial Applications for Nebraska Agriculture, University of Nebraska Cooperative Extension CD 6, by M. Milner, D.A. Mortensen, K.G. Cassman, and W.J. Waltman, revised in October 2003. Map Series 96:0091, a cooperative project of the Departments of Agronomy and Horticulture and Computer Science and Engineering, University of Nebraska-Lincoln.)

less growing-degree-day hybrid, optimum harvest population was above 30,000 plants while with a growing-degree-day hybrid of 2700 or more, the optimum harvest population was 26,000 plants.

Seeding rates for corn in Nebraska under rainfed conditions have ranged from approximately 8,000 to 24,000 plants per acre. Water requirements of corn only decrease if population is less than 18,000 plants per acre. Corn yields increase from 6 to 12 bushels per acre for each additional inch of soil water beyond the 8-11 inches needed for initial grain development. Many agronomists feel that maximum production is reached with a 0.5 pound ear weight. Under dryland conditions, an ear weight of 0.6 pound may be a more desirable goal in areas with a longer growing season, but in areas such as the Nebraska Panhandle, a 0.4 lb ear may be optimum year in and out. This would provide some insurance if a drought occurred. *Table I* lists the harvest plant population needed for yield goals from 40 to 170 bushels per acre based upon ear weights of 0.4 and 0.6 pounds.

Table I. Yield goal vs plant population at harvest.

Yield goal	*Population 0.4 lb ears*	*Population 0.6 lb ears*	*Yield goal*	*Population 0.4 lb ears*	*Population 0.6 lb ears*
bu/A	plants/A		bu/A	plants/A	
40	7,000	4,670	110	19,250	12,830
50	8,750	5,830	120	21,000	14,000
60	10,500	7,000	130	22,700	15,170
70	12,250	8,170	140	24,500	16,330
80	14,000	9,330	150	26,250	17,500
90	15,750	10,500	160	28,000	18,670
100	17,500	11,670	170	29,750	19,830

There has been a tendency for increased yields with the higher populations in favorable years, but as population is increased, the risk of disaster also increases. Plant population increases do not necessarily decrease the amount of water available to each plant by a proportional amount. The reason is that as plant population increases, leaf canopy increases, which reduces the amount of direct sunlight reaching the soil surface. Wind movement within the canopy also is reduced as population increases. Both of these effects help the growing crop. The shade reduces the soil temperature, which in turn reduces surface evaporation. With high levels of crop

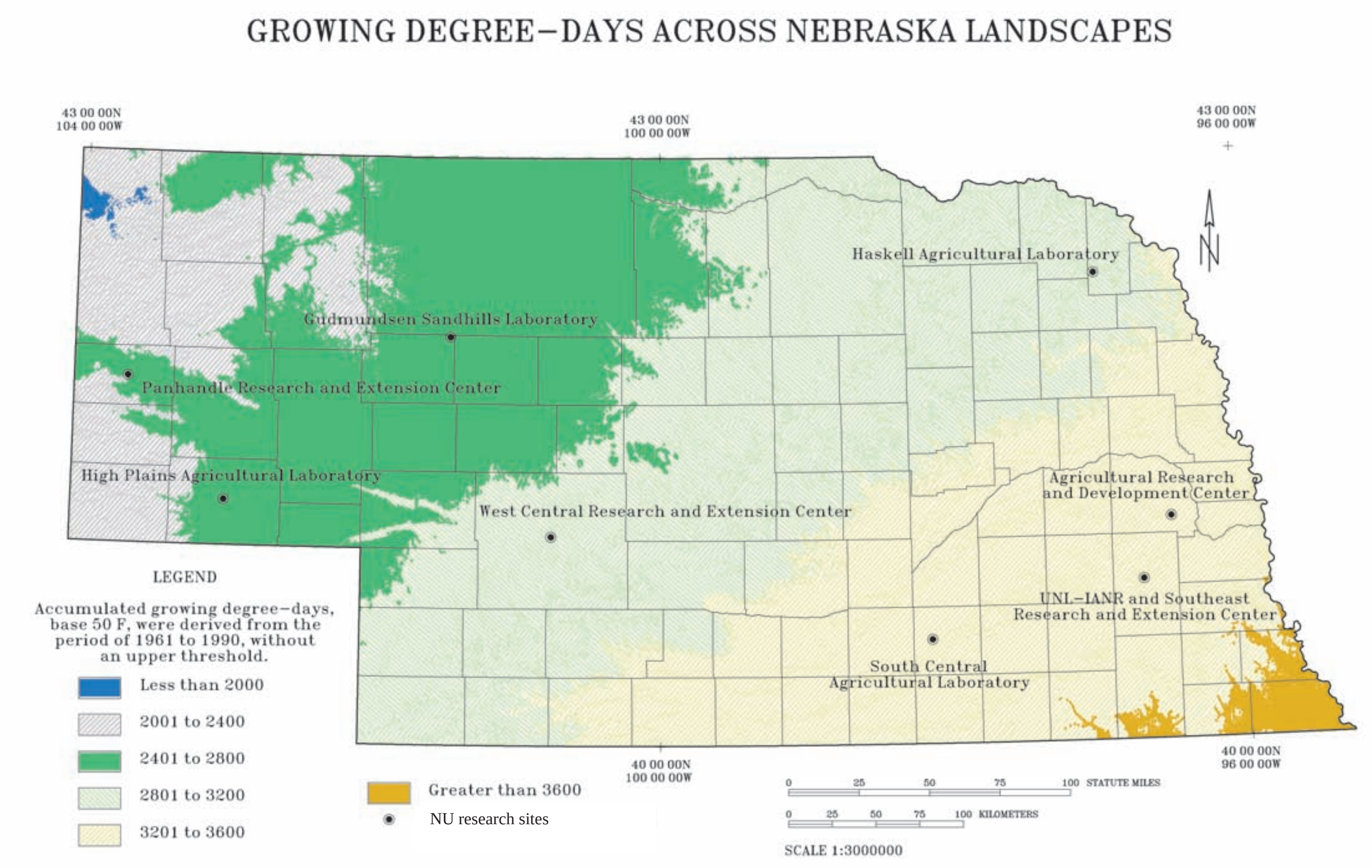

Figure 2. **Accumulated growing degree-days, base 50, in Nebraska, representing the total heat units available for plant growth through the year. Albers Equal Area Projection. The growing degree-day surface was generated from a terrain regression model applied to the USGS 3 arc-second digital elevation models (DEMs; 1:250,000) with a final resolution fo 200 m. (From Geospatial Applications for Nebraska Agriculture, University of Nebraska Cooperative Extension CD 6, by M. Milner, D.A. Mortensen, K.G. Cassman, and W.J. Waltman, revised in October 2003. Map Series 96-0091, a cooperative project of the Department of Agronomy and Horticulture and Computer Science and Engineering, University of Nebraska-Lincoln.)**

residue, this effect is reduced. Reduced wind movement also decreases surface evaporation and tends to keep the humidity in the canopy a bit higher, which lowers transpiration rate. The higher population also creates some mutual shading, which keeps the leaves somewhat cooler. This, too, reduces the transpiration rate.

At present, corn plant populations of approximately 8,000 to 16,000 plants per acre in 30-inch rows are recommended for rainfed production in western Nebraska. In a two-year, multiple site field study conducted in western Nebraska in 1999 and 2000, optimum dryland corn population varied from less than 7,000 established plants per acre to more than 23,000 plants per acre, depending largely on available water resources. These data were used to validate a corn growth simulation model that was then coupled with long-term sequences of historical climatic data (1948-2001) from western Nebraska to estimate dryland yield for a range of corn populations. Simulated populations ranged from 8,000 to 20,000 established plants per acre.

Simulations had one of three levels of available soil water at planting, either 3.1, 6.3, or 9.4 inches in the top 5 feet of a loam soil, representing one-third, two-thirds, and full soil water profiles, respectively. At Sidney, Nebraska median yields (half of the yields are greater than the median and half are less) were maximized at 8,000, 12,000, and 16,000 established plants per acre for starting available water levels of 3.1, 6.3,

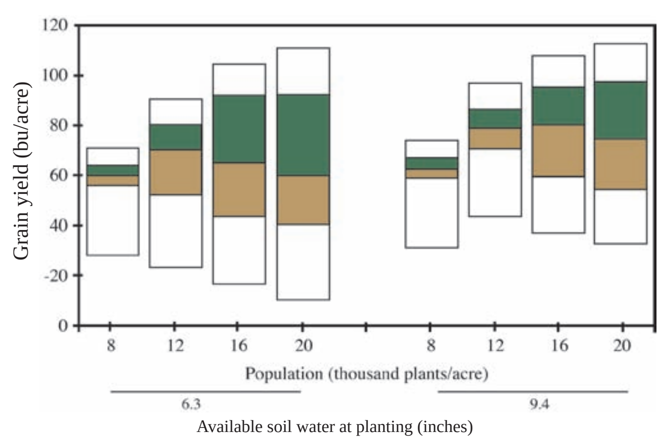

Figure 3. **Range of yields for various plant populations and available soil water, Sidney, Nebraska. Extremes on each bar encompass the range between minimum and maximum values. Extremes of the colored section of each bar encompass the range between the 25 and 75 percent quartiles, and the horizontal line within each colored section shows the median.**

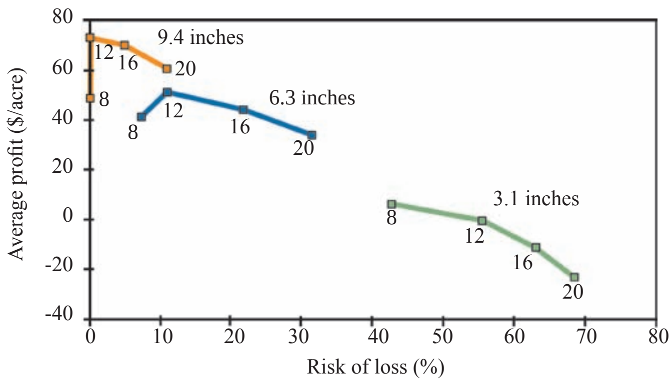

Figure 4. Average profit vs. risk of loss at Sidney, Nebraska with soil water at planting at 3.1, 6.3 and 9.4 inches and 8,000, 12,000, 16,000 and 20,000 established plants. (P = $2.13/bu; FC = $62.19/acre; N = $0.24/lb; S = $100/bag; H = $0.15/bu)

and 9.4 inches, respectively *(Figure 3)*. Gross margins were maximized at 12,000 established plants per acre when starting available water was 6.3 or 9.4 inches. The probability of a financial loss at this population was reduced from about 10 percent at 6.3 inches to 0 percent at 9.4 inches *(Figure 4)*. When starting available water was 3.1 inches, average gross margins were less than $6.10 per acre and risk of financial loss exceeded 40 percent. Median yields were greatest when starting available soil water was 9.4 inches; however, perhaps the greater benefit of additional soil water at planting was a reduced risk of financial loss.

See *Table II* for planting rates, row widths, and harvest population and *Table III* for suggested harvest populations for moisture and residue conditions when planting on silt loam soils. Remember, lower plant populations are not as competitive with weeds.

Table II. Average planting rate, seed spacing in inches and projected harvest populations for corn.

Planting rate/acre	*Row width*			*Harvest population*	
	20 inches	*30 inches*	*36 inches*	*10% Loss*	*15% Loss*
	Inches between seeds			Plants/A	
6,000	52.3	34.8	29.0	5,400	5,100
8,000	39.2	26.1	21.8	7,200	6,800
10,000	31.4	20.9	17.4	9,000	8,500
12,000	26.1	17.4	14.5	10,800	10,200
14,000	22.4	14.9	12.4	12,600	11,900
16,000	19.6	13.1	10.9	14,400	13,600
18,000	17.4	11.6	9.7	16,200	15,300
20,000	15.6	10.5	8.7	18,000	17,000
22,000	14.3	9.5	7.9	19,800	18,700
24,000	13.1	8.7	7.3	21,600	20,400
26,000	12.1	8.0	6.7	23,400	22,100
28,000	11.2	7.5	6.2	25,200	23,800
30,000	10.5	7.0	5.8	27,000	25,500

Table III. Suggested harvest populations for moisture and residue conditions at planting on silt loam soils in Nebraska. Even distribution of residue is assumed.

Area	*Mid-Season corn*	*Short-season corn*
With 2000 lb/A wheat residue or 4000 lb corn/sorghum, or 55% residue cover and 2 feet of sub-soil moisture.		
Western	--------------- Do not plant corn ---------------	
Central	12,000	13,000
Eastern	16,000	17,000
3500 lb/A wheat residue or 7000 lb corn/sorghum or 90% residue cover and 4 feet of sub-soil moisture.		
Western	10,000	11,000
Central	14,000	15,000
Eastern	18,000	19,000
5000 lb/A wheat residue or 100% residue cover and 6 feet of sub-soil moisture.		
Western	12,000	13,000
Central	15,000	16,000
Eastern	20,000	21,000

1. 100 lbs of residue are produced for each bushel of winter wheat and 50 lbs of residue is produced for each bushel of corn or sorghum produced.
2. For continuous no-till, the residue could be a combination of the winter wheat residue and corn or grain sorghum residue.
3. Requires equipment that can plant or drill through residues.
4. Long season corn hybrids are not recommended. If used, reduce plant population.

This publication has been peer reviewed.

UNL Extension publications are available online at *http://extension.unl.edu/publications*.

Index: Field Crops
Corn

Issued December 2003